भारतीय मानक
Indian Standard

IS 3657 : 2018

रेडियोग्राफिक इमेज गुणवत्ता संकेत की विशिष्टि

(दूसरा पुनरीक्षण)

Specification for Radiographic Image Quality Indicators

(Second Revision)

ICS 11.040.50

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-Destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Radiographic inspection is mandatory in certain types of constructions and fabrications in the industrial field. Due to the rapid development of industries demanding radiographic inspection, the application of X-rays and gamma rays in industrial radiography has considerably increased in the country over the last 25 years. The quality of radiographs obtained during such inspections is an important factor since, the clarity with which the defects are revealed depends on it. The quality of the radiographs, in turn, depends on various factors, such as the radiographic technique, exposure conditions and the type of film.

Radiographic image quality indicators provide a basis, whereby, the image quality of the radiographs obtained may be assessed more uniformly and unambiguously. It provides an objective check on the correctness of the technique used in making a radiograph by recording in each radiograph the image of an image quality indicator. The device is made of the same or similar material as that under examination and is generally placed on the side of the specimen facing the source of radiation. The radiographic sensitivity figure, calculated from the image of the image quality indicator, should be considered only as giving an indication of the sensitivity obtained and bears no direct relation with the type and size of the minimum defect likely to be revealed by the radiograph. In other words, the image quality indicator sensitivity does not necessarily represent flaw sensitivity.

The standard was first published in 1966 and its first revision, with few modifications, was adopted in the month of April 1978. After a gap of nearly thirty five years Non-destructive Sectional Committee decided to carry out second revision of this standard to incorporate latest development, if any, in the field of radiographic image quality indicators.

Accordingly, this document has been reviewed and the following changes/modifications have been incorporated:

(a) Table 1, Table 2 and Table 3 — Title of each table has been modified and each table has been re-formatted;

(c) All the figures have been re-drawn for more clarity; and

(b) Following three new clauses related to equivalent sensitivity have been incorporated:

1) *Clause* **9.4** equivalent Image Quality Indicator (IQI) Sensitivity 'S_E'
2) *Clause* **9.5** equivalent Image Quality Indicator (IQI) Sensitivity for Strip Hole Type Indicators
3) *Clause* **9.6** Wire size equivalent to Strip Hole Type Indicators.

Under these new clauses, definition of and formula for Equivalent Image Quality Indicator (IQI) Sensitivity 'S_E' and few worked out example (Table 5) have been added. Table 6 gives equivalent image quality percentage sensitivity for various image quality levels of strip hole type indicators. Clause **9.6** highlights the formula and calculation for finding out wire size equivalent to strip hole type indicators.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SPECIFICATION FOR RADIOGRAPHIC IMAGE QUALITY INDICATORS

(Second Revision)

1 SCOPE

This standard covers the requirements of three types of radiographic image quality indicators. It also includes their method of use and assessment of sensitivity.

2 REFERENCES

The following Indian Standard contains provisions, which through reference in this text, constitute provision of this standard. At the time of the publication, the edition indicated below was valid. All the standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility applying the most recent edition of the standard.

IS No.	Title
IS 2478 : 1991	Glossary of terms relating to industrial radiology (*second revision*)

3 TERMINOLOGY

For the purpose of this standard definitions given in IS 2478 shall apply.

4 TYPES

This standard covers the following three types of image quality indicators:

a) Wire type : consisting of wires of different diameters;

b) Step hole type : consisting of drilled holes of different diameters and in steps of different thicknesses; and

c) Strip hole type : consisting of through drilled holes of three different diameters on uniformly thick strip.

NOTE — Only one arrangement for each type of indicator has been covered in this standard. In the case of step hole type indicator, it is permissible to have fewer or more steps than those specified and it is possible to have the step arranged in a different pattern for steps. In case of strip hole type indicator, it is permissible to have different combination of holes (with regard to diameter) and/or different thickness than those specified in Table 3 and Fig. 3. Such indicator may be used by mutual agreement between the parties concerned.

5 MATERIAL

5.1 For all the three types of image quality indicators, the wires, or metal strips shall normally be of the same base material and have the same coefficient of absorption as the specimen being radiographed.

5.2 In the case of ferrous materials, an image quality indicator of low carbon steel is normally adequate for use on all types of steel. An image quality indicator made of special steel, namely, stainless, may be used when there is an extensive application to that particular alloy.

5.3 For aluminium alloys, where there is insufficient application justifying production of image quality indicator of the same alloy as the one under examination, an image quality indicator of pure aluminium may be used. For copper and its alloys, an image quality indicator of copper is usually adequate.

5.4 When the indicator is protected by a covering, this shall not be absorbent so as to prevent any alteration to the visibility of wires or holes.

6 CONSTRUCTION OF INDICATORS

6.1 Wire Type Indicator

6.1.1 *General*

The wires incorporated in the image quality indicators shall be parallel to one another, spaced with a distance between the axes of the wires of not less than three times the larger wire diameter and in no case less than 5 mm (*see* Fig. 1), and arranged in order of increasing diameter. The wires shall be mounted between two thin sheets of a low X-ray absorbent, optically transparent material, such as polyethylene sheets. The sheets shall be fastened securely together so as to ensure that the wires do not move. The mount shall preferably be flexible and the material of the mount adjacent to the wires as thin as possible.

6.1.2 *Number of Wires and Their Length*

The wire type image quality indicator shall consist of seven straight wires, each having a length of 50 mm and of diameters prescribed for each of the models described under **6.1.3**.

6.1.3 *Models*

There shall be five models of wire type image quality indicator to suit different ranges of thickness of the material being examined. The diameters of wires to be used in the construction of the different models and the range of thicknesses of material for which these are recommended to be used are given in Table 1.

6.1.4 *Tolerance on Diameters*

The tolerance on wire diameters shall be as follows:

Wire Diameter mm	*Tolerance* mm
Up to 0.125	± 0.005
Over 0.125 up to 0.5	± 0.01
Over 0.5 up to 1.6	± 0.02
Over 1.6 up to 3.2	± 0.03

Table 1 Diameters of Wires for Different Models and Thicknesses of Materials for Wire Type Indicator

(*Clause* 6.1.3)

Material of the		**Model**	**Wire Diameter, mm**			**Recommended for Use with Material of Thickness, mm**	
Test Specimen	**Wires**					**From**	**To**
(1)	(2)	(3)		(4)		(5)	(6)
Iron and Steel	Steel	Fe 1	0.06	0.08	0.10	—	12
			0.12	0.16	0.20		
			0.25				
		Fe 2	0.12	0.16	0.20	12	25
			0.25	0.32	0.40		
			0.50				
		Fe 3	0.25	0.32	0.40	25	50
			0.50	0.64	0.80		
			1.00				
		Fe 4	0.50	0.64	0.80	50	100
			1.00	1.25	1.60		
			2.00				
		Fe 5	0.80	1.00	1.25	Over 100	—
			1.60	2.00	2.50		
			3.15				
Aluminium and its Alloys		Al 1	0.06	0.08	0.10	—	12
			0.12	0.16	0.20		
			0.25				
		Al 2	0.12	0.16	0.20	12	25
			0.25	0.32	0.40		
			0.50				
		Al 3	0.25	0.32	0.40	25	50
			0.50	0.64	0.80		
			1.00				
		Al 4	0.50	0.64	0.80	50	100
			1.00	1.25	1.60		
			2.00				
		Al 5	0.80	1.00	1.25	Over 100	
			1.60	2.00	2.50		
			3.15				

Table 1 *(Concluded)*

Material of the		Model	Wire Diameter, mm			Recommended for Use with Material of Thickness, mm	
Test Specimen	**Wires**					**From**	**To**
(1)	(2)	(3)		(4)		(5)	(6)
Copper and its Alloys	Copper	Cu 1	0.06	0.08	0.10	—	Up to 12
			0.12	0.16	0.20		
			0.25				
		Cu 2	0.12	0.16	0.20	12	25
			0.25	0.32	0.40		
			0.50				
		Cu 3	0.25	0.32	0.40	25	50
			0.50	0.64	0.80		
			1.00				
		Cu 4	0.50	0.64	0.80	50	100
			1.00	1.25	1.80		
			2.00				
		Cu 5	0.80	1.00	1.25	Over 100	—
			1.60	2.00	2.50		
			3.15				

NOTE — The wire sizes for each of the models are so selected as to give a radiographic sensitivity of **1 to 4** percent for the lowest thickness of the material in the range and **0.5 to 2.0** percent for the highest thickness of the material in the range. The range of sensitivity covered is more than sufficient for normal radiographic inspection. If, for the lowest thickness of material in the range, radiographic sensitivity of less than one percent is required, next lower model may be used. Similarly, if a radiographic sensitivity of more than 2 percent is desired for the highest thickness of the material in the range, the next higher model may be used.

6.2 Step Hole Type Indicator

6.2.1 *General*

The step hole type indicator may be either made from a single plate and a series of steps of different thicknesses may be obtained by machining, or for flexibility, separate strips of appropriate thickness may be mounted on low X-ray absorbent thin plastic material or rubber.

6.2.2 *Number of Steps and Holes and Their Dimensions*

6.2.2.1 The step hole type image quality indicator shall consist of five steps of thicknesses specified under **6.2.3**, each containing one or two holes, having diameters specified in Table 2, drilled through the full thickness and at right angles to the upper surface. The diameter of the holes shall be equal to the thickness of the step. Each step, except the thickest of the series, shall be 12.5 mm square. The thickest step of the series shall be 12.5 × 25 mm in dimensions.

6.2.2.2 Steps of thickness equal to or greater than 0.8 mm shall contain only one hole. Steps having thickness less than 0.8 mm shall contain two holes. The holes shall not be less than 3 mm apart and the distance from the centre of the hole to the edge of step shall not be less than 3 mm. Where there is a single hole on each step, it shall be located in the centre of the step. The location of the hole for the thickest step shall be as indicated in Fig. 2. The holes shall be through and normal to the surface of the indicator. The holes should not be chamfered.

6.2.3 *Models*

There shall be five models of step hole type image quality indicator to suit the different ranges of thickness of the material being examined. Table 2 gives the thickness of the steps and the diameters of the holes for each of the models and the range of thickness for which each of the models is recommended for use.

6.2.4 *Tolerances on Diameters of Holes and Thickness of Steps*

The tolerance on diameter of holes and thickness of steps shall be as follows:

Step Thickness/ Hole Diameter mm	Tolerance mm
Up to 0.5	+ 0.015 – 0
Over 0.5 up to 1	+ 0.02 – 0
Over 1 up to 2.5	+ 0.025 – 0
Over 2.5	+ 0.03 – 0

Table 2 Thickness of Steps and Diameters of Holes for Different Models of Step Hole Type Indicator

(*Clauses* 6.2.2 *and* 6.2.3)

Material of the		Model No.	Step Thickness/ Diameter of Holes mm			Recommended for Use with Material of Thickness, mm	
Test Specimen	Indicator					From	To
(1)	(2)	(3)		(4)		(5)	(6)
Iron and Steel	Steel	Fe 1	0.16	0.20	0.25	—	16
			0.32	0.40			
		Fe 2	0.32	0.40	0.50	16	32
			0.63	0.80			
		Fe 3	0.63	0.80	1.00	32	64
			1.25	1.60			
		Fe 4	1.25	1.60	2.00	64	128
			2.5	3.2			
		Fe 5	2.5	3.2	4.00	—	Over 128
			5.0	6.3			
Aluminium and its Alloys	Aluminium	Al 1	0.16	0.20	0.25	—	16
			0.32	0.40			
		Al 2	0.32	0.40	0.50	16	32
			0.63	0.80			
		Al 3	0.63	0.80	1.00	32	64
			1.25	1.60			
		Al 4	1.25	1.60	2.00	64	128
			2.5	3.2			
		Al 5	2.5	3.2	4.00	—	Over 128
			5.0	6.3			
Copper and its Alloys	Copper	Cu 1	0.16	0.20	0.25	—	16
			0.32	0.40			
		Cu2	0.32	0.40	0.50	16	32
			0.63	0.80			
		Cu3	0.63	0.80	1.00	32	64
			1.25	1.60			
		Cu 4	1.25	1.60	2.00	64	128
			2.5	3.2			
		Cu 5	2.5	3.2	4.00	—	Over 128
			5.0	6.3			

NOTE — The thickness of the step and diameter of the hole of the models is so selected as to enable the lowest thickness of the material in the range being examined with a radiographic sensitivity of 2 to 5 percent and the highest thickness of the material in the range with radiographic sensitivity of 1 to 2.5 percent. The range of sensitivity covered is sufficient for normal radiographic inspection. If, for the lowest thickness of material in the range, sensitivity less than 2 percent is required, the next lower model may be used.

6.3 Strip Hole Type Indicator

6.3.1 The strip hole type indicator shall be a single, uniformly thick plate with three holes.

6.3.2 *Number of Holes and Other Dimensions*

The strip hole type indicator shall have three holes along a straight line. The diameters of the holes shall be 4*T,* 1*T,* and 2*T* where *T* is equal to thickness of the indicator plate except in the case mentioned in **6.3.2.2**. For the indicators up to thickness 1.270 mm the minimum dimensions of the plate shall be 12.5 mm × 44 mm. For those over 1.270 mm and up to 3.05 mm inclusive, the minimum dimension of the plate shall be 25.0 mm × 66 mm.

6.3.2.1 The holes shall be through and normal to the surface of the indicator. The holes should not be chamfered.

6.3.2.2 The diameters of the holes in indicator with $T \leq 0.25$ mm shall be 1.00 mm, 0.25 mm and 0.50 mm respectively, irrespective of the value of *T*.

6.3.3 *Models*

The identification numbers of the IQI, the thickness of it and the recommended ranges of thickness of the material being examined shall be as given in Table 3.

Table 3 Identification and Thickness of Different Models of Strip Hole Type Indicators

(*Clause* 6.3.3)

Identification No. of Indicator	Thickness of the Indicator Plate (T) mm	Recommended for the Use with Material of Thickness mm
(1)	(2)	(3)
5	0.125	Up to 6
7	0.180	Over 6 and up to 9
10	0.250	Over 9 and up to 13
12	0.300	Over 13 and up to 15
15	0.380	Over 15 and up to 19
17	0.430	Over 19 and up to 22
20	0.510	Over 22 and up to 26
25	0.635	Over 26 and up to 32
30	0.760	Over 32 and up to 38
35	0.890	Over 38 and up to 45
40	1.015	Over 45 and up to 51
45	1.140	Over 51 and up to 57
50	1.270	Over 57 and up to 64
60	1.520	Over 64 and up to 76
80	2.030	Over 76 and up to 100
100	2.540	Over 100 and up to 128
120	3.050	Over 128

NOTE — Recommended ranges of thickness selected are such that the sensitivity between 2 and 3 percent is achieved. If sensitivity outside this figure is required, the indicator which will give sensitivity nearest to the required sensitivity may be used.

6.3.4 *Tolerances*

Tolerances on indicator thickness and hole diameter shall be as follows:

Strip Thickness/Hole Dia mm	*Tolerance* mm
Up to 0.5	+ 0.015 – 0.0
Over 0.5 up to 1	+ 0.02 – 0.00
Over 1 up to 2.5	+ 0.025 – 0.00
Over 2.5	+ 0.03 – 0.00

7 MARKING

7.1 Wire Type Indicator

7.1.1 Each indicator shall have the following marks incorporated in the form of lead symbols of sufficient thickness so as to show them clearly on the radiograph:

a) Letters ‘IS’ to indicate that it complies with this standard, followed by the Model No., *for example*, IS Fe 1; and

b) Last two digits of the year of adoption, *for example*, if the year of adoption is 2012, ‘12’.

7.1.2 The positions and dimensions of marking shall be as shown in Fig. 1.

7.2 Step Hole Type Indicator

7.2.1 Each indicator shall have the following marks incorporated on the thickest of the steps in the form

of lead symbols so as to show them clearly on the radiograph:

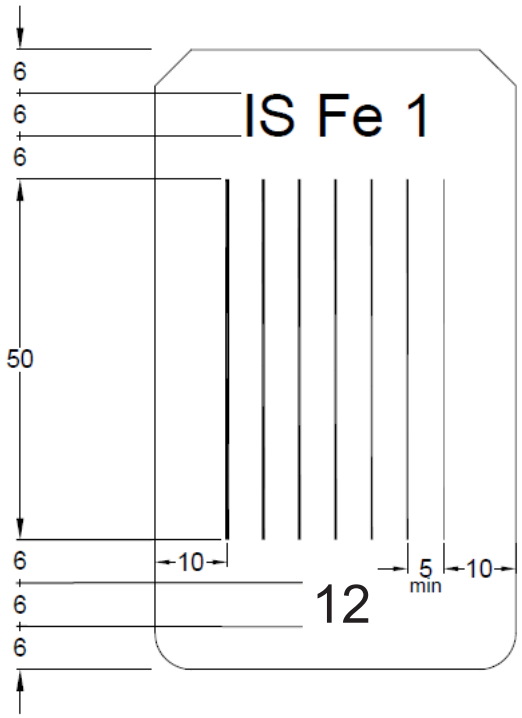
a) Letters 'IS', to indicate that it complies with this standard, followed by the Model No., *for example*, IS Cu 5; and

b) Last two digits of the year of adoption, *for example*, if the year of adoption is 2012, '12'.

7.2.2 The position and dimensions of markings shall be as shown in Fig. 2.

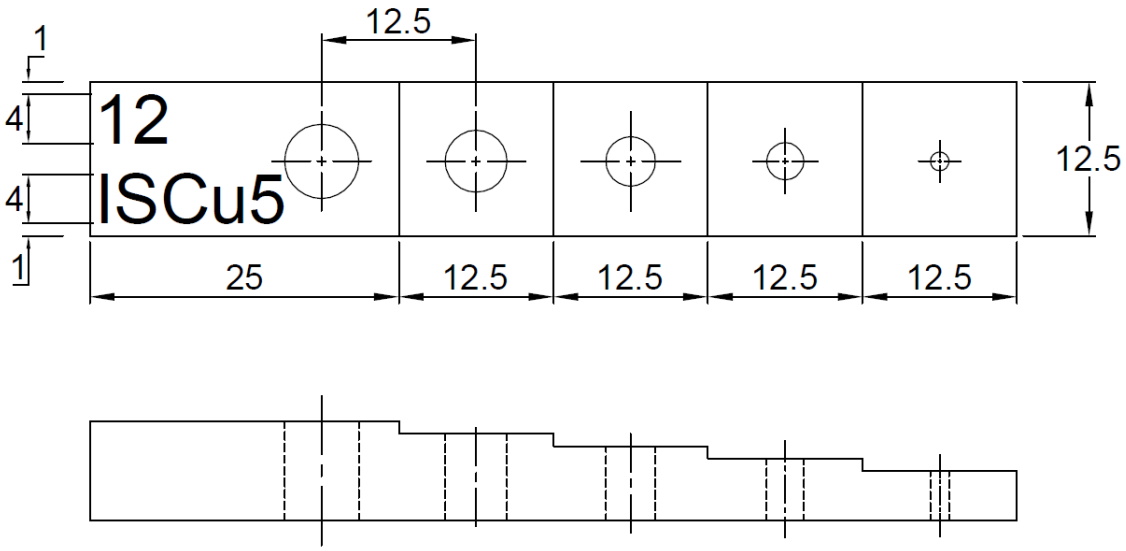
7.3 Strip Hole Type Indicator

7.3.1 Each indicator shall have the following marks incorporated at one end of the plate in the form of lead symbol so as to show them clearly on the radiograph:



All dimensions in millimeters

FIG. 1 WIRE TYPE IMAGE QUALITY INDICATOR



All dimensions in millimeters

FIG. 2 STEP HOLE TYPE IMAGE QUALITY INDICATOR

a) The model identification number as given in Table 3; and

b) Identification of the material, like Cu, Fe, etc.

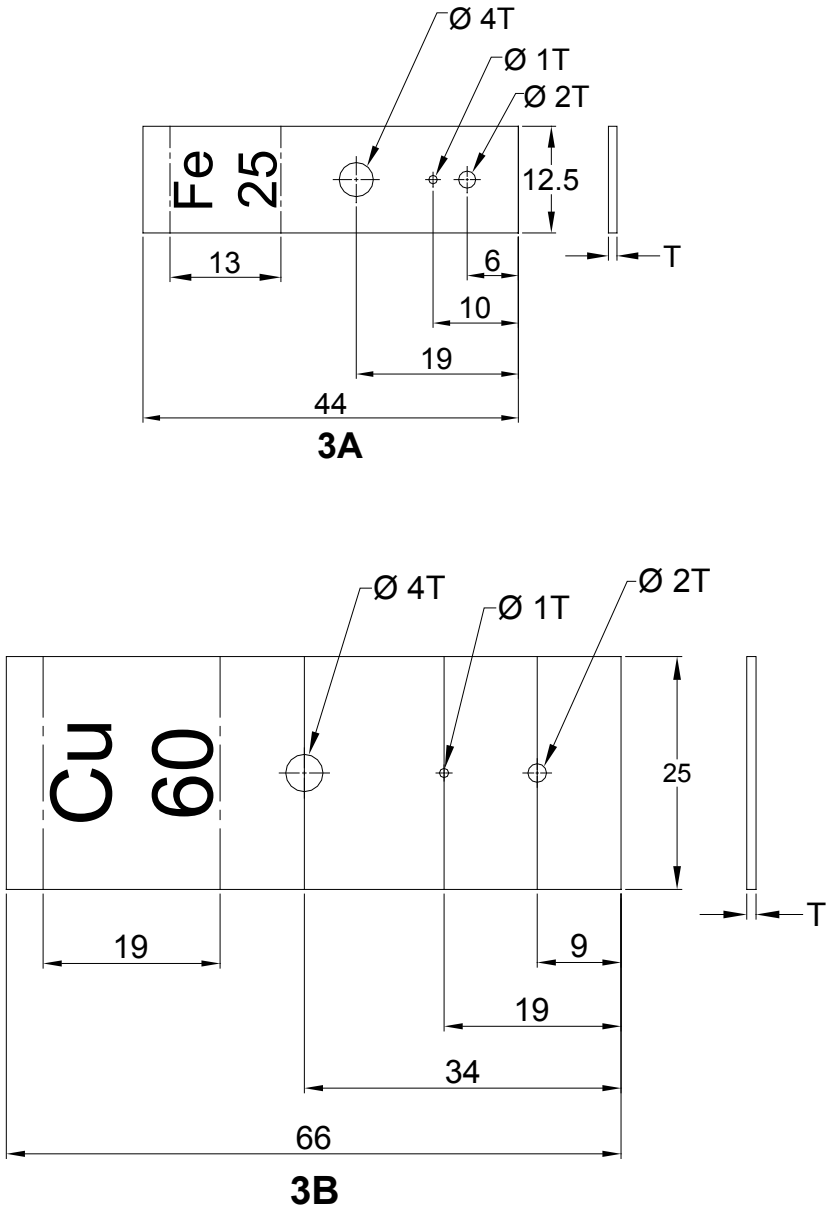
NOTE — Alternately, the material may be identified by other methods like notches on the edge of the indicator and shall be as mutually agreed upon by the contracting parties.

7.3.2 The position and dimension of marking shall be as shown in Fig. 3.

8 METHODS OF USING THE INDICATORS

8.1 An image quality indicator should normally be placed on the side of the specimen remote from the film, that is, the side facing the source of radiation and as close as possible to the surface of the specimen under examination. The wire or hole, which is smallest in diameter, shall be placed nearest to the end. When there is any difference between the angularities of radiation at the two ends, the image quality indicator shall be placed at the end of the maximum angularity.

8.2 If the surface facing the source is inaccessible, as in the case of double wall exposures on pipe welds, the indicator may be placed on the film side and in that case it should be specifically mentioned in the report since the sensitivity indicated will not be the true value of sensitivity.



All dimensions in millimeters

FIG. 3 STRIP HOLE TYPE INDICATOR DESIGN

8.3 It is important that the thickness of the material under image quality indicator is approximately the same as the maximum thickness to be inspected on that particular radiograph. If the portion of the specimen where the indicator is placed is less thick than the specimen to be tested, appropriate spacer should be used between the indicator and the specimen. The thickness of the spacer should be equal to the difference in thicknesses between the two portions of the specimen. If the thickness range to be covered on one radiograph is large, appropriate image quality indicators should be placed on both the maximum and minimum thicknesses.

8.4 In weld radiography, the wire type indicator should be placed across the weld so that the wires lie transverse to the direction of the weld. The step hole type image quality indicator should, however, be placed close to and parallel with the weld with a thickness compensating spacer underneath if the weld metal thickness exceeds the thickness of the parent metal by more than 10 percent.

8.5 When a circumferential weld is radiographed with a single exposure, each film shall have an image quality indicator. When the number of films is more than four, a minimum of four image quality indicators shall be uniformly placed, one in each quadrant.

9 ASSESSMENT OF SENSITIVITY

9.1 To assess the radiographic sensitivity, the radiograph should be visually inspected on a film viewer of adequate brightness and with the radiograph correctly masked to eliminate glare. The viewing should be done in a darkened room.

9.2 Wire Type/Step Hole Type Indicator

9.2.1 The diameter of the thinnest wire or the smallest drilled hole, which may be detected by eye with certainty, is taken as a criterion of the sensitivity attained. In the case of step hole type IQI if there are two drilled holes, in a relevant step, both should be visible. On weld radiographs using the wire type image quality indicator, the assessment should be made in the weld area.

9.2.2 The sensitivity figure is calculated as a percentage ratio of the thinnest wire or the smallest hole visible to the maximum thickness of the material under examination, that is,

Radiographic sensitivity, percent =

$$\frac{\text{Diameter of the smallest wire or hole visible}}{\text{The maximum thickness of material}} \times 100$$

Thus, the lower the numerical value of this ratio, the higher is the sensitivity.

9.2.3 *Index of Visibility*

The sensitivity may also be determined on the index of visibility which is determined by the following formula:

$$N = a - b$$

where,

N = index of visibility,

a = number of holes or wires visible on the radiograph, and

b = number of holes or wire whose diameters are equal to or larger than 5 percent of the thickness in the case of step type indicator and 2 percent of the thickness in the case of the wire type indicator.

9.2.3.1 The image quality is considered to be better with the higher values of *N*.

9.2.3.2 The approximate relationship between the visibility index (*N)* and the sensitivity percentage is shown in Table 4.

Table 4 Visibility Index

(*Clause* 9.2.3.2)

Visibility Index	Sensitivity, Percent	
	Wire Type Indicator	Step Hole Type Indicator
(1)	(2)	(3)
− 1	2.5 to 3.2	6.3 to 8.0
0	2.0 to 2.5	5.0 to 6.3
+ 1	1.6 to 2.0	4.0 to 5.0
+ 2	1.25 to 1.6	3.2 to 4.0
+ 3	1.0 to 1.25	2.5 to 3.2
+ 4	0.8 to 1.0	2.0 to 2.5

9.3 Strip Hole Type Indicator

The diameter of the smallest hole, which may be detected by unaided eye with certainty together with the thickness of the indicator, is taken as a criterion of the sensitivity obtained. It shall be referred as, for example, 2-1T, 1-4T, etc. (where the first number indicates the thickness of the indicator as percentage of object thickness and the second number refers to the hole diameter as multiple of the indicator thickness).

9.4 Equivalent Image Quality Indicator (IQI) Sensitivity 'SE'

It is defined as that thickness of the IQI expressed as a percentage of the part thickness, in which the 2T hole would be visible under the same radiographic conditions.

Mathematically, Equivalent IQI Sensitivity 'S_E' is expressed as:

$$S_E = n\sqrt{\frac{H}{2T}} \quad \ldots\ldots \text{(F1)}$$

$$\text{or, } S_E = \frac{100}{X}\sqrt{\frac{TH}{2}} \quad \ldots. \text{(F2)}$$

X = Specimen thickness,

n = IQI thickness expressed as percentage of specimen thickness 'X',

T = IQI thickness, and

H = Diameter of the smallest visible hole in terms of IQI thickness 'T'.

Depending upon the convenience either of the formulae (F1) or (F2) can be used since both produce the same result as shown below.

$$\because T = \frac{nX}{100} \therefore n = \frac{100T}{X}$$

$$S_E = n\sqrt{\frac{H}{2T}} = \frac{100T}{X}\sqrt{\frac{H}{2T}} = \frac{100}{X}\sqrt{\frac{HT^2}{2T}} = \frac{100}{X}\sqrt{\frac{TH}{2}}$$

Example:

A steel specimen with 31.75 mm thickness is to be radiographed using IQI No. 25 to achieve a sensitivity of 2-4T. However, due to non-availability, instead of IQI No. 25, IQI No. 30 is used. It is required to find out the diameter of the hole in IQI No. 30, whose image will give sensitivity equal to or better than 2-4T, under the same radiographic conditions.

Solution: For specimen thickness X = 31.75 mm, from Table 3, Strip Hole Type Indicators No. = 25, Thickness of IQI No. 25 = 0.635 mm and Thickness of IQI No. 30 = 0.760 mm.

Sample calculations are shown in the Table 5.

9.5 Equivalent Image Quality Indicator (IQI) Sensitivity for Strip Hole Type Indicators

Some time it may not be feasible to get IQI of required thickness for the given sensitivity requirement. In such cases if IQI of different thickness is used, based on the diameter of the smallest visible hole an Equivalent IQI Sensitivity 'S_E' can be determined using either formula F1 or F2 given in **9.4**, for comparing the sensitivities of required and selected IQI. Equivalent Image Quality Indicator (IQI) sensitivity for different combination of holes and thicknesses of Strip Hole Type Indicators are given in Table 6.

Table 5 Calculations for Equivalent IQI Sensitivity

(*Clause* 9.4)

Sl. No.	IQI Detail	Using Formula $S_E = n\sqrt{\frac{H}{2T}}$	Using Formula $S_E = \frac{100}{X}\sqrt{\frac{TH}{2}}$
(1)	(2)	(3)	(4)
(i)	IQI No. = 25, T = 0.635 mm, Visible hole diameter H = 4T = 4 × 0.635 mm	$n = \frac{100T}{X}$ $n = \frac{100 \times 0.635}{31.75} = 2.0\%$ $S_E = 2\sqrt{\frac{4T}{2T}} = 2\sqrt{2} = 2.8\%$	$S_E = \frac{100}{31.75}\sqrt{\frac{T.4T}{2}}$ $= \frac{100}{31.75} \times T\sqrt{2}$ $S_E = \frac{100}{31.75} \times 0.635 \times \sqrt{2}$ $S_E = 2.8\%$
(ii)	IQI No.= 30, T = 0.760 mm	$n = \frac{100T}{X}$ $n = \frac{100 \times 0.760}{31.75} = 2.39\%$	$S_E = \frac{100}{31.75}\sqrt{\frac{T.H.}{2}}$
ii (a)	If 1T hole is visible, then H = 1T	$S_E = 2.39\sqrt{\frac{1T}{2T}} = 2.39\ \sqrt{\frac{1}{2}} = 1.69\%$	$S_E = \frac{100}{31.75}\sqrt{\frac{T.T}{2}} = 1.69\%$
ii (b)	If 2T hole is visible, then H = 2T	$S_E = 2.39\sqrt{\frac{2T}{2T}} = 2.39\%$	$S_E = \frac{100}{31.75}\sqrt{\frac{T.2T}{2}} = 2.39\%$
ii (c)	If 4T hole is visible, then H = 4T	$S_E = 2.39\sqrt{\frac{4T}{2T}} = 2.39\sqrt{2} = 3.38\%$	$S_E = \frac{100}{31.75}\sqrt{\frac{T.4T}{2}} = 3.38\%$

NOTES:

1 For IQI No. 25, since the thickness of IQI is 2 percent of the specimen thickness, image of 4T hole corresponds to sensitivity of 2-4T which is numerically equivalent to 2.8 percent.

2 In IQI No. 30, with 2T hole visibility, equivalent IQI sensitivity of 2.39 percent is the most nearest value to the required sensitivity of 2.8 percent. Hence, 4T hole of IQI No. 25 is equivalent to 2T hole of IQI No. 30.

3 As per the definition of the equivalent Image Quality Indicator (IQI) sensitivity, image of 2T hole (diameter 1.52 mm) in an IQI having thickness of 0.76 mm which is 2.39 percent of the specimen thickness (31.75 mm) will be visible under the same radiographic conditions.

Table 6 Equivalent IQI Sensitivity for Strip Hole Type Indicators

(*Clause* 9.5)

Sl. No.	Image Quality Levels	IQI Thickness Percent (Fraction) of Specimen Thickness	Minimum Perceptible Hole Diameter	Equivalent IQI Sensitivity Percent
1	1-1T	1 percent $\left\{\frac{1}{100}\right\}$	1T	0.7
2	1-2T	1 percent $\left\{\frac{1}{100}\right\}$	2T	1.0
3	1-4T	1 percent $\left\{\frac{1}{100}\right\}$	4T	1.4
4	2-1T	2 percent $\left\{\frac{1}{50}\right\}$	1T	1.4
5	2-2T	2 percent $\left\{\frac{1}{50}\right\}$	2T	2.0
6	2-4T	2 percent $\left\{\frac{1}{50}\right\}$	4T	2.8
7	4-1T	4 percent $\left\{\frac{1}{25}\right\}$	1T	2.8
8	4-2T	4 percent $\left\{\frac{1}{25}\right\}$	2T	4.0
9	4-4T	4 percent $\left\{\frac{1}{25}\right\}$	4T	5.6

9.6 Wire Size Equivalent to Strip Hole Type Indicators

The equation to determine the equivalencies between wire and strip hole type indicators is as follow:

$$F^3D^3L = T^2H^2\left[\frac{\pi}{4}\right] \text{ or, } D = \sqrt[3]{\frac{T^2.H^2(\pi/4)}{F^3.L}} \quad \text{…….. (F3)}$$

F = form factor for wire, 0.79;

D = wire diameter, (mm);

L = effective length of wire (0.3 inch or 7.6 mm);

T = thickness of indicator plate, in mm; and

H = diameter of hole (mm).

Example: For Strip Hole Type Indicators No. 25, Thickness T = 0.635 mm and H = 2 × 0.635 = 1.27. Wire diameter D for 2-2T sensitivity level can be calculated by using equation (F3) as shown below:

$$D = \sqrt[3]{\frac{T^2.H^2(\pi/4)}{F^3.L}} = \sqrt[3]{\frac{0.635^2 \times 1.27^2(\pi/4)}{0.79^3 \times 7.6}} \approx 0.52 \text{ mm}$$

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